

CLAIMS

What is claimed is:

- 1 1. A method comprising:
2 calibrating a wireless access point, which includes at least two antenna
3 subsystems, wherein a first antenna subsystem includes a first transmit chain and a
4 first receive chain, and a second antenna subsystem includes a second transmit chain
5 and a second receive chain, and wherein calibrating includes adjusting a gain of at
6 least one of the first antenna subsystem and the second antenna subsystem so that a
7 first gain ratio between the first transmit chain and the first receive chain
8 approximately equals a second gain ratio between the second transmit chain and the
9 second receive chain.

- 1 2. The method of claim 1, further comprising:
2 the first transmit chain transmitting a first signal, which represents a
3 modified version of first input data;
4 the second receive chain receiving the first signal and producing a modified
5 version of the first signal as first output data;
6 the second transmit chain transmitting a second signal, which represents a
7 modified version of second input data;
8 the first receive chain receiving the second signal and producing a modified
9 version of the second signal as second output data; and
10 wherein calibrating the wireless access point includes adjusting the gain of at
11 least one of the first antenna subsystem and the second antenna subsystem so that
12 the first output data approximately equals the second output data.

- 1 3. The method of claim 2, wherein:
2 transmitting the first signal comprises transmitting the first signal over a
3 wireless channel; and

4 transmitting the second signal comprises transmitting the second signal over
5 the wireless channel.

1 4. The method of claim 2, wherein:

2 transmitting the first signal comprises transmitting the first signal over a
3 wireless channel simulator; and

4 transmitting the second signal comprises transmitting the second signal over
5 the wireless channel simulator.

1 5. A method comprising:

2 exchanging a plurality of wireless signals with a plurality of antenna
3 subsystems of a wireless access point; and

4 calibrating the plurality of antenna subsystems, based on measurements of
5 the wireless signals, so that gain ratios for selected ones of the plurality of antenna
6 subsystems are approximately equal, wherein a gain ratio is a ratio of an antenna
7 subsystem's transmit chain gain to an antenna subsystem's receive chain gain.

1 6. The method of claim 5, wherein calibrating the plurality of antenna

2 subsystems comprises adjusting at least one gain of at least one transmit chain.

1 7. The method of claim 5, wherein calibrating the plurality of antenna

2 subsystems comprises adjusting at least one gain of at least one receive chain.

1 8. A method comprising:

2 a transmit chain of a first antenna subsystem transmitting a first signal,
3 which represents a modified version of first input data;

4 a receive chain of a second antenna subsystem receiving the first signal and
5 producing a modified version of the first signal as first output data;

6 a transmit chain of the second antenna subsystem transmitting a second
7 signal, which represents a modified version of second input data;

8 a receive chain of the first antenna subsystem receiving the second signal
9 and producing a modified version of the second signal as second output data; and

10 adjusting a gain of at least one of the first antenna subsystem and the second
11 antenna subsystem so that the first output data approximately equals the second
12 output data.

1 9. The method of claim 8, further comprising:
2 a receive chain of a third antenna subsystem receiving the first signal and
3 producing a modified version of the first signal as third output data;
4 a transmit chain of the third antenna subsystem transmitting a third signal,
5 which represents a modified version of third input data;
6 the receive chain of the first antenna subsystem receiving the third signal and
7 producing a modified version of the third signal as fourth output data; and
8 adjusting a gain of at least one of the first antenna subsystem and the third
9 antenna subsystem so that the third output data approximately equals the fourth
10 output data.

1 10. The method of claim 8, further comprising:
2 the transmit chain of the first antenna subsystem transmitting a third signal,
3 which represents a modified version of third input data;
4 a receive chain of a third antenna subsystem receiving the third signal and
5 producing a modified version of the third signal as third output data;
6 a transmit chain of the third antenna subsystem transmitting a fourth signal,
7 which represents a modified version of fourth input data;
8 the receive chain of the first antenna subsystem receiving the fourth signal
9 and producing a modified version of the fourth signal as fourth output data; and
10 adjusting a gain of at least one of the first antenna subsystem and the third
11 antenna subsystem so that the third output data approximately equals the fourth
12 output data.

1 11. The method of claim 8, further comprising:
2 the transmit chain of the second antenna subsystem transmitting a third
3 signal, which represents a modified version of third input data;

4 a receive chain of a third antenna subsystem receiving the third signal and
5 producing a modified version of the third signal as third output data;
6 a transmit chain of the third antenna subsystem transmitting a fourth signal,
7 which represents a modified version of fourth input data;
8 the receive chain of the second antenna subsystem receiving the fourth
9 signal and producing a modified version of the fourth signal as fourth output data;
10 and
11 adjusting a gain of at least one of the second antenna subsystem and the third
12 antenna subsystem so that the third output data approximately equals the fourth
13 output data.

1 12. A method comprising:
2 computing a plurality of receive chain gains of a plurality of receive chains
3 of a plurality of antenna subsystems;
4 computing a plurality of transmit chain gains of a plurality of transmit chains
5 of the plurality of antenna subsystems; and
6 adjusting one or more gains of one or more of the plurality of receive chains
7 and the plurality of transmit chains so that gain ratios for selected ones of the
8 plurality of antenna subsystems are approximately equal, wherein a gain ratio is a
9 ratio between an antenna subsystem's transmit chain gain to the antenna
10 subsystem's receive chain gain.

1 13. The method of claim 12, wherein computing the plurality of receive chain
2 gains comprises applying an input signal to selected ones of the plurality of receive
3 chains, measuring output signals of the selected ones of the plurality of receive
4 chains, and comparing the output signals to the input signal.

1 14. The method of claim 12, wherein computing the plurality of transmit chain
2 gains comprises, for a selected antenna subsystem, subtracting a receive chain gain
3 for the antenna subsystem from a total gain through a transmit chain of the antenna
4 subsystem and the receive chain of the antenna subsystem.

- 1 15. An apparatus comprising:
2 a first antenna subsystem, which includes a first transmit chain and a first
3 receive chain;
4 a second antenna subsystem, which includes a second transmit chain and a
5 second receive chain; and
6 a processing element, which is operable to adjust a gain of at least one of the
7 first antenna subsystem and the second antenna subsystem so that a first gain ratio
8 between the first transmit chain and the first receive chain approximately equals a
9 second gain ratio between the second transmit chain and the second receive chain.
- 1 16. The apparatus of claim 15, further comprising at least one additional antenna
2 subsystem.
- 1 17. The apparatus of claim 15, further comprising a channel simulator, operably
2 connected between the first antenna subsystem and the second antenna subsystem,
3 over which the first signal and the second signal are transmitted.
- 1 18. The apparatus of claim 15, further comprising a calibration signal source,
2 operably connected to the first receive chain and the second receive chain, which
3 provides the first calibration signal and the second calibration signal.
- 1 19. The apparatus of claim 15, further comprising:
2 a first coupling circuit, operably connected between the first transmit chain
3 and the first receive chain; and
4 a second coupling circuit, operably connected between the second transmit
5 chain and the second receive chain.
- 1 20. A wireless local area network access point comprising:
2 a first antenna subsystem, which includes a first transmit chain and a first
3 receive chain;

4 a second antenna subsystem, which includes a second transmit chain and a
5 second receive chain; and
6 a processing element, which is operable to adjust a gain of at least one of the
7 first antenna subsystem and the second antenna subsystem so that a first gain ratio
8 between the first transmit chain and the first receive chain approximately equals a
9 second gain ratio between the second transmit chain and the second receive chain.

1 21. The wireless local area network access point of claim 20, further comprising
2 a channel simulator, operably connected between the first antenna subsystem and
3 the second antenna subsystem, over which the first signal and the second signal are
4 transmitted.

1 22. The wireless local area network access point of claim 20, further comprising
2 a calibration signal source, operably connected to the first receive chain and the
3 second receive chain, which provides the first calibration signal and the second
4 calibration signal.

1 23. The wireless local area network access point of claim 20, further comprising:
2 a first coupling circuit, operably connected between the first transmit chain
3 and the first receive chain; and
4 a second coupling circuit, operably connected between the second transmit
5 chain and the second receive chain.

1 24. A system comprising:
2 an access point, which includes
3 a first antenna subsystem, which includes a first transmit chain and a
4 first receive chain,
5 a second antenna subsystem, which includes a second transmit chain
6 and a second receive chain, and
7 a processing element, which is operable to adjust a gain of at least
8 one of the first antenna subsystem and the second antenna subsystem so

9 that a first gain ratio between the first transmit chain and the first receive
10 chain approximately equals a second gain ratio between the second
11 transmit chain and the second receive chain; and
12 a plurality of stations, which are capable of transmitting first information to
13 and receiving second information from the access point.

1 25. The system of claim 24 wherein the system is a spatial-division, multiple-
2 access system.

1 26. The system of claim 24, wherein the system is a wireless local area network
2 system.

1 27. A computer-readable medium having program instructions stored thereon to
2 perform a method of calibrating a wireless access point, which when executed
3 within the wireless access point, result in:
4 calibrating a wireless access point, which includes at least two antenna
5 subsystems, wherein a first antenna subsystem includes a first transmit chain and a
6 first receive chain, and a second antenna subsystem includes a second transmit chain
7 and a second receive chain, and wherein calibrating includes adjusting a gain of at
8 least one of the first antenna subsystem and the second antenna subsystem so that a
9 first gain ratio between the first transmit chain and the first receive chain
10 approximately equals a second gain ratio between the second transmit chain and the
11 second receive chain.

1 28. The computer-readable medium of claim 27, wherein the method, when
2 executed, further results in:
3 the first transmit chain transmitting a first signal, which represents a
4 modified version of first input data;
5 the second receive chain receiving the first signal and producing a modified
6 version of the first signal as first output data;

7 the second transmit chain transmitting a second signal, which represents a
8 modified version of second input data;
9 the first receive chain receiving the second signal and producing a modified
10 version of the second signal as second output data; and
11 wherein calibrating the wireless access point includes adjusting the gain of at
12 least one of the first antenna subsystem and the second antenna subsystem so that
13 the first output data approximately equals the second output data.

1 29. The computer-readable medium of claim 27, wherein:
2 transmitting the first signal comprises transmitting the first signal over a
3 wireless channel; and
4 transmitting the second signal comprises transmitting the second signal over
5 the wireless channel.

1 30. The computer-readable medium of claim 27, wherein:
2 transmitting the first signal comprises transmitting the first signal over a
3 wireless channel simulator; and
4 transmitting the second signal comprises transmitting the second signal over
5 the wireless channel simulator.